A Novel SPECT Microscopy System for 3D Imaging of Single Stem Cells In Vivo

Grant Award Details

A Novel SPECT Microscopy System for 3D Imaging of Single Stem Cells In Vivo

Grant Type: Tools and Technologies I

Grant Number: RT1-01027

Investigator:

Name:	Douglas Wagenaar
Institution:	Gamma Medica-Ideas, Inc.
Type:	PI

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Progress Reports

Reporting Period: Year 1

View Report

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Grant Application Details

Application Title: A Novel SPECT Microscopy System for 3D Imaging of Single Stem Cells In Vivo

Public Abstract:

There are two main avenues of discovery open to medical scientists to find cures or alleviate suffering in people: 1) pharmaceuticals and 2) stem cells. Both of these branches of research use the emerging technological tools of imaging, genetic engineering and nanotechnology to explore new ways to manipulate molecular and cellular processes. In this project, called "Nicola", we boldly propose to do what has yet to be done, that is to make images of individual stem cells within a living animal (i.e., a lab mouse). In order to determine the location of the cells relative to recognizable structures, we will create a "dual-modality" imager that will use MRI images for scientists to see where the single cells are located within the mouse. It should be noted that other methods such as optical (visible light), PET, MRI, etc. have shown signals from multiple (usually thousands) cells but only optical microscopy of thin slices of tissue on a glass sample slide have demonstrated single cell identification. Optical methods involving very thin fibre optics threads can "see" individual cells within a living mouse, but only to a depth of 0.3 millimeters from the end of the fibre. Users of the optical microscopy methods request a new method of see individual cells within a larger volume of the intact animal. Our proposal begins with a prototype that is designed to image one cubic centimeter, which is thousands of times the volume of the optical fibre method above. Furthermore, this is only the beginning - if our method proves to be feasible the volume can expand to ultimately have clinical utility in humans. The final goal of this project then is to visualize single stem cells within a several cubic centimeter volume of a human patient- that is, to view an organ or tissue undergoing stem cell repair. This large-field-of-view microscope would function within an MRI imaging system to provide a backdrop for the physician to know the location of the cells. The current proposal is a feasibility study that pushes the boundaries of technical capability to demonstrate, for the first time, single cell imaging within a living mouse. This is a necessary first step toward the ultimate goal of following the clinical course of action of therapeutic stem cells within human patients in the future.

Statement of Benefit to California:

Nuclear imaging is one of the last holdouts from the vacuum tube electronics age. Currently more than 95% of all nuclear imagers sold today continue to employ vacuum tube technology. [REDACTED] is the leading manufacturer of solid-state nuclear imagers for medical research applications. [REDACTED] is primarily in the field of photon-counting, using x-rays and gamma-rays to generate images in computed tomography (CT), single photon emission tomography (SPECT), and positron emission tomography (PET). [REDACED] is at the forefront of research and development in all three of these important fields. Although CT has used solid-state electronics for about 20 years now, [REDACTED] is at the forefront in R&D efforts to count and record the energy of each detected x-ray photon; all previous CT scanners have integrated thousands of photons into just one signal. The potential gains in information transfer for photon-counting CT technology are only beginning to be articulated but they are expected to be a quantum leapover conventional CT. With SPECT, [REDACTED] has introduced solid-state CZT for medical imaging research in both small animal imaging as well as clinical breast applications. In PET, [REDACTED] has introduced another solid-state detector based on avalanche photodiodes (APDs). For the current proposal, [REDACTED] has created a super-high resolution, silicon “Megapixel” detector with 50 micron intrinsic resolution. Again, this allows nuclear imaging without the use of vacuum tubes. With no vacuum tubes,the Megapixel detector is MRI-compatible and can be used for the proposed dual-modality application. The high-performance imaging technology and the systems engineering prowess of [REDACTED] are unique to this California company and superior to any that can be found in the world. The stem cell research group at [REDACTED] in regenerative medicine is led by [REDACTED]. This group has extensive experience in all modalities of imaging of stem cells – many types of optical microscopy, nuclear techniques, MR, ultrasound, and x-ray CT. They have studied the shortcomings of each modality and measured them against their needs. They desperately require an in vivo imaging modality that can identify the location of individual stem cells. The expertise in research with stem cells, labeling them, modifying them, studying their differentiation and survival in vivo – all of these reside in the world-class California-based research team at [REDACTED]. [REDACTED] and his staff have worked together with the [REDACTED] o perform preliminary experiments and to identify the need for the proposed technology. We believe this unique combination of instrumentation and stem cell expertise are a valuable natural research that only resides within the State of California.

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